Coastal Engineering Technical Note

GROIN SYSTEM TRANSITIONS

PURPOSE: To present a method for determining groin lengths and spacing for transitions between a series of groins and the natural beach.

GENERAL: An important consideration in the functional design of any groin system is the possibility of increased erosion downdrift of these structures. In order to avoid the abrupt change in the shore alignment that may result in erosion of the downdrift beach, transitional groins (groins of gradually reduced lengths) may be used. A method for the design of a groin system transition that involves groin shortening has been used by the U.S. Army Engineer District, Wilmington (1973). Kessner (1928) conducted model studies on groin transitions and more recently Bruun (1952) applied the principle of groin shortening at the end of groin systems.

PROCEDURE: A schematic of a groin system transition is shown below.

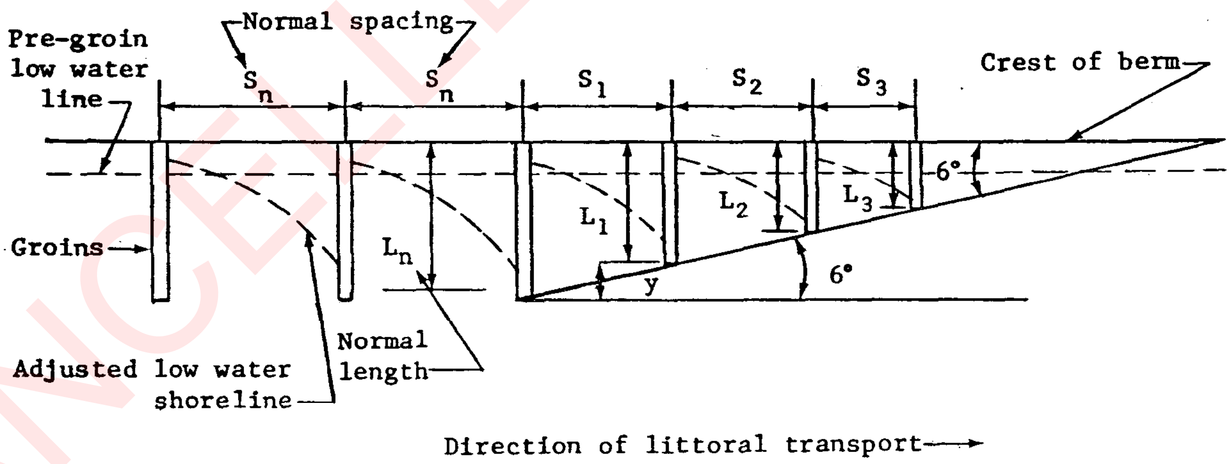

Figure. Schematic of Groin-shortening Procedure

U.S. Army Corps of Engineers, Coastal Engineering Research Center, Kingman Building, Fort Belvoir, VA 22060

Groin System Transitions: The principle of groin shortening is employed at the end of groin systems in order to develop a transition between the groin system and the adjacent natural beach and to reduce downdrift erosion. Where there are reversals in the direction of longshore littoral transport, transitions would be appropriate for both ends of the groin system. Bruun (1952) indicates that in a long series of groins, the shortening should probably be carried out on the updrift side also, to insure a smooth passage to the unprotected coast. He further indicates that if the series consists only of a few groins, the shortening should start with the second groin from the updrift end. This would result in all the groin system being a transitional section. Kressner (1928) found in model tests that only three or four groins need to be shortened at the downdrift end of the system (see the figure).

He also found that the transition is most effective if a line connecting the seaward ends of the shortened groins and the last full length groin meets the natural shore alignment at an angle of about 6 degrees, as shown in the figure. Further, Bruun indicates that a 6 degree angle has been successfully used. *The length of a groin, "L", is measured from the crest of the beach berm to the seaward end.* (The actual groin length extends shoreward of the berm.) The limit of shortening is a judgment decision of the designer; but, in the case of tidal coastal areas, it is suggested that the last transitional groin extend to no less than the mean lower low water (MLLW) line.

With "y" being the shortening, "L_n" the normal groin length, "L_1" the length of the first shortened groin, "L_2" the length of the second shortened groin, "L_3" the length of the third shortened groin, etc., and "S" the spacing between groins; then

$$y = S_1 \tan 6^\circ \tag{1}$$

and

$$\left.\begin{aligned} L_1 &= L_n - y \\ \text{or} \quad L_1 &= L_n - S_1 \tan 6^\circ \end{aligned}\right\} \tag{2}$$

then

$$L_2 = L_1 - S_2 \tan 6^\circ \tag{3}$$

and

$$L_3 = L_2 - S_3 \tan 6^\circ \tag{4}$$

Groin Spacing in Transitions. According to the general design criterion suggested in the *Shore Protection Manual* (Section 5.66), the normal spacing between groins should be 2 to 3 times their length. The groin spacing within the zone of shortening should decrease so that the design ratio between spacing and length is maintained. Since the lengths of the groins in this zone differ, *the space-to-length ratio, "R", is based on the average length of adjacent groins.* By maintaining this ratio, "R", the spacings shown on the figure are:

$$S_1 = \left(\frac{L_n + L_1}{2}\right)R \; , \tag{5}$$

$$S_2 = \left(\frac{L_1 + L_2}{2}\right)R \; , \tag{6}$$

and

$$S_3 = \left(\frac{L_2 + L_3}{2}\right)R \; . \tag{7}$$

Since the length of transitional groins and their spacings are interdependent, the equations for lengths and spacing are combined as follows:

$$L_1 = \left(\frac{1 - \frac{R}{2}\tan 6^\circ}{1 + \frac{R}{2}\tan 6^\circ}\right) L_n \tag{8}$$

and

$$S_1 = \left(\frac{R}{1 + \frac{R}{2}\tan 6^\circ}\right) L_n \; . \tag{9}$$

* * * * * * * * * * * * * * * * * EXAMPLE * * * * * * * * * * * * * * * * * *

The example computation is based on shortening of the three groins shown in the figure. If the normal spacing of a groin field, "S_n," is 500 feet and the normal groin length, "L_n," is 250 feet, then

$$R = \frac{Sn}{L_n} = \frac{500}{250} = 2.0$$

then using Equation (8)

$$L_1 = \left(\frac{1 - \frac{R}{2}\tan 6^\circ}{1 + \frac{R}{2}\tan 6^\circ}\right) L_n = \left[\frac{1 - \frac{2.0}{2}\,(0.105)}{1 + \frac{2.0}{2}\,(0.105)}\right] 250 = 0.81\ (250) = 203 \text{ feet,}$$

$$L_2 = 0.81\ L_1 = 0.81\ (203) = 164\ \text{feet},$$

$$L_3 = 0.81\ L_2 = 0.81\ (164) = 133\ \text{feet}.$$

Using Equation (9)

$$S_1 = \left(\frac{R}{1 + \frac{R}{2}\tan 6^{\circ}}\right) L_n = 1.81\ (250) = 453\ \text{feet},$$

$$S_2 = 1.81\ L_1 = 1.81\ (202) = 366\ \text{feet},$$

and

$$S_3 = 1.81\ L_2 = 1.81\ (164) = 297\ \text{feet}.$$

Using Equations (2) and (5) as a check on the above calculations, the following is obtained:

$$L_1 = L_n - S_1 \tan 6^{\circ} = 250 - 453(0.105) = 203\ \text{feet}$$

and

$$S_1 = \left(\frac{L_n + L_1}{2}\right) R = \left(\frac{250 + 203}{2}\right) 2.0 = 453\ \text{feet}.$$

* *

<u>ADDITIONAL INFORMATION</u>: For additional information contact the Coastal Engineering Studies Section, Wilmington District (919)343-4778 or FTS 671-4778.

<u>REFERENCES</u>:

BRUUN, P., "Measures Against Erosion at Groins and Jetties," *Proceedings of the Third Conference on Coastal Engineering*, Cambridge, MA., October 1952.

KRESSNER, B., "Tests with Scale Models to Determine the Effect of Currents and Breakers upon a Sandy Beach, and the Advantageous Installation of Groins," *The Technical High School of the Free City of Danzig, Construction Methods*, Vol. 25, Berlin, June 1928.

U.S. ARMY, CORPS OF ENGINEERS, COASTAL ENGINEERING RESEARCH CENTER, *Shore Protection Manual*, 3d ed., Vols. I, II, and III, Stock No. 008-022-00113-1, U.S. Government Printing Office, Washington, D.C., 1977, 1,262 pp.

U.S. ARMY ENGINEER DISTRICT, WILMINGTON, "Hurricane-Wave Protection - Beach-Erosion Control Brunswick County, N.C., Beach Projects, Yaupon Beach and Long Beach Segments," General Design Memorandum - Phase I, Wilmington, N.C., July 1973.